DOE/RL-2003-49, Rev. 0

100-FR-3 Operable Unit Sampling and Analysis Plan

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management
Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

**United States
Department of Energy**
**P.O. Box 550
Richland, Washington 99352**

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Concurrence: Keith A. Klein 9/29/03
U.S. Department of Energy, Richland Operations Office

Signature ____________ Date 9/25/03

Concurrence: Dennis A. Faulk
U.S. Environmental Protection Agency

Signature ____________ Date 10-1-03

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Summary

The objective of this sampling and analysis plan is to continue long-term groundwater monitoring as well as extend the study of the effect that contamination at the100-FR-3 Operable Unit has had on the near-shore environment of the Columbia River. This plan also provides guidance for measuring the decay or decline in concentration of contamination already in groundwater. No active groundwater remediation of the 100-FR-3 Operable Unit has been planned, and no date has been set for publication of the record of decision on final remedial measures for the unit.

The 100-FR-3 Operable Unit includes the groundwater near the 100-F Area containing contamination from past-practice discharges. This operable unit does not include the surface sources themselves, nor does it include the original structures that comprised the 100-F complex.

The activities described in this plan were the outcome of a data quality objectives process that identified two needs: (1) to revise the boundaries of the 100-FR-3 Operable Unit to include an area that was geographically connected to the current operable unit boundaries that might contain information useful in assessing the migration of groundwater contamination and (2) to enhance the shoreline monitoring to determine the impact of residual contaminants coming from the 100-FR-3 Operable Unit. The revised monitoring network is made up of wells, shoreline seeps, and aquifer sampling tubes either already in the ground near the 100-F Area or being planned for installation.

Wells Used in the Revised Monitoring Network for the 100-FR-3 Operable Unit

199-F1-2	199-F5-45	199-F7-3	699-62-43F	699-69-45
199-F5-1	199-F5-46	199-F8-2	699-63-25A	699-71-30
199-F5-3	199-F5-47	199-F8-3	699-63-51	699-71-52
199-F5-4	199-F5-48	199-F8-4	699-63-55	699-74-44
199-F5-42	199-F5-6	699-58-24	699-64-27	699-77-36
199-F5-43A	199-F6-1	699-60-32	699-65-50	699-77-54
199-F5-43B	199-F7-1	699-61-37	699-66-23	699-83-47
199-F5-44	199-F7-2	699-62-31	699-67-51	699-84-35A

The groundwater will be monitored for six constituents of concern (hexavalent chromium, nitrate, strontium-90, trichloroethene, uranium, and tritium).

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1.0 Introduction

The 100-F Area was one of nine established nuclear reactor areas on the Hanford Site involved in the production of plutonium. Unlike the other reactor areas, the 100-F Area also contained an experimental biological research station. Like other 100 Area sites, initial groundwater monitoring at the 100-F Area began during reactor operations and focused on relatively few chemical and radiological constituents. Monitoring at the 100-F Area has changed (DOE/RL-91-53) to encompass the entire list of possible contaminants that could have been used and/or disposed of at the reactor site. The conclusion of detailed investigations conducted under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) led to a long-term monitoring approach that centered on defining the extent of contamination and reporting on the changes in concentration for a limited number of contaminants.

The objective of this sampling and analysis plan, as defined in the *Data Quality Objectives Summary Report* (PNNL-14287), is to bridge the gap between data obtained from earlier investigations and the information required to support remedial action decisions. This plan also provides guidance for measuring the decay or decline in concentration of contamination already in groundwater. No active groundwater remediation of the 100-FR-3 Operable Unit has been planned, and no date has been set for publication of the record of decision on final remedial measures for the unit. This plan addresses monitoring requirements for CERCLA and the *Atomic Energy Act of 1954*.

1.1 Background

The 100-FR-3 Operable Unit includes soil and groundwater near the 100-F Area containing contamination from past-practice discharges to surface facilities (e.g., cribs) near the F Reactor (DOE/RL-90-08). The unit also includes some element of the Columbia River shoreline. This operable unit does not include the surface sources themselves, nor does it include the original structures that comprised the 100-F complex.

Groundwater contamination occurred near the reactors during their operational lifespan (1945-1965). Waste stream categories identified in the *Remedial Investigation/ Feasibility Work Plan for the 100-FR-3 Operable Unit, Hanford Site, Richland, Washington* (DOE/RL-91-53) include the following:

- Reactor process liquid waste and cooling water effluent
- Radioactive sludge/solid waste
- Reactor ventilation systems and inert gas system waste
- Animal research operations waste
- Sanitary liquid waste
- Non-radioactive liquid waste
- Non-radioactive solid waste

Wastewater discharges to the surface and to the Columbia River varied in their contamination levels. The single-pass design of the cooling system used in all but one Hanford reactor meant that water passed through the reactor from the storage basins and to the point of discharge within hours of being drawn from the river. Water discharges to the Columbia River were retained for a time to assure that short-lived radionuclides had decayed to relatively low radioactivity levels and to lower the temperature of the effluent entering the river. The timing of liquid discharges to ground was often based on the type of discharge. Condensate from process systems and septic systems, for example, were generally discharged on a continuous basis, whereas discharges from highly radioactive sources were sporadic and often followed an event such as the rupture of fuel cladding in the reactor.

The CERCLA source areas that contribute to groundwater contamination are the surface and subsurface disposal facilities that were associated with the operations at the 100-F Area. Many of these structures and their ancillary systems are undergoing active remediation. The Tri-Party Agreement (Ecology et al. 1998) listed 30 individual sources aggregated into two source operable units (100-FR-1 and 100-FR-2). Other than the 105-F reactor building itself, several specific categories of waste sites were identified in the work plan:

- Retention basin area, including the 116-F-14 retention basin, the 116-F-2 overflow trench, and other areas associated with the control of cooling water from the retention basin.

- Cribs and trenches used to dispose of liquid wastes associated with operation of the 105-F Reactor. These include the 116-F-1 Lewis Canal, 116-F-3 fuel storage basin trench, 116-F-4 pluto crib, 116-F-5 ball washer crib, and the 116-F-6 liquid waste trench.

- Trenches and burial areas used for disposal of liquid and solid waste associated with the animal research laboratories, which includes the 116-F-9 animal waste leach trench.

Several of these waste sites have either recently been remediated or are undergoing active remediation. The waste sites comprise the surface soil and structures associated with the 100-FR-1 and 100-FR-2 Operable Units.

These waste disposal facilities provided mechanisms, both intentional and unintentional, for radioactive and chemical contaminants to flow through the vadose zone and reach groundwater. After the reactors were shut down, the facilities continued to provide a source of groundwater contamination as less-mobile constituents have migrated slowly through the vadose zone to reach groundwater. Recharge from natural precipitation and the effects of bank storage from the Columbia River alter the concentration of contaminants entering groundwater. The amount of radioactive contaminants reaching the river from sources within the 100-F Area can be estimated based on samples obtained from aquifer sampling tubes at the shoreline of the Columbia River and from groundwater seeps along the banks near the river shore.

1.2 Previous Monitoring Network

Historic Hanford Site reports issued during the operational history describing groundwater-monitoring activities in the 100 Areas (e.g., Brown and Raymond 1962) contained few references to chemical constituents now recognized as hazardous materials or radionuclides contributing to risk. Early groundwater reports instead concentrated on thermal increases in groundwater, as well as nitrate and tritium concentrations near the river. No specific number of wells, or the well identification numbers, was disclosed in these early reports.

An agreement to add the Hanford 100 Areas to the National Priority List (NPL) and manage hazardous waste under federal environmental regulations placed the 100-F Area under CERCLA. The monitoring network created in response was covered in a Federal Facility Agreement and Consent Order (or the Tri-Party Agreement; Ecology et al. 1998) change control form (change control form #39, provided in Appendix A), a mechanism created to allow for interim modification of cleanup milestones. The initial monitoring network, created while the work plan (DOE/RL-91-53) was being completed, relied on 22 wells to monitor the operable unit and was sampled for target compound list organics, target analyte list inorganics, and radiological constituents (see Appendix A of DOE/RL-91-53). The network was sampled quarterly for two sampling events in 1992 after which the work plan (DOE/RL-91-53) became the operating guidance document for monitoring. The work plan identified several constituents of concern that were subsequently dropped because concentrations reported from sampling were consistently below regulatory thresholds.

The *Limited Field Investigation Report for the 100-FR-3 Operable Unit* (DOE/RL-93-83) issued in 1994 contained constituents of potential concern that were identified after nearly three years of groundwater sampling and analysis for a variety of chemical and radiological constituents. The constituents of concern included arsenic, chromium, copper, lead, manganese, nitrate/nitrite, strontium-90, and tritium.

The monitoring activity that is currently regarded as 'long-term monitoring-CERCLA' (LTMC) was formed to carry forward the monitoring program begun under the work plan (DOE/RL-91-53) and the limited field investigation (DOE/RL-93-83). The objective of the LTMC program is to collect data to support an interim or a final record of decision that will cover remediation and post-cleanup groundwater monitoring of the 100-FR-3 Operable Unit. The LTMC program began in 1996 with the release of a new change control form (M-15-96-06, Appendix A) that narrowed the focus of monitoring at the 100-F Area to those constituents that had either exceeded the Environmental Protection Agency's (EPA) maximum contaminant level, or had not been sampled sufficiently to characterize their effect on groundwater. The new network had grown to 35 wells and 3 seeps, and the constituent list included metals, anions, volatile organics, gamma scan, gross beta, gross alpha, carbon-14, strontium-90, technetium-99, tritium, specific conductance, pH, and temperature. These constituents were analyzed in two rounds of annual sampling beginning in 1996 (Round 8) and culminating in 1998 (Round 9). The Round 9 constituent list also included turbidity. The LTMC program was moved to Pacific Northwest National Laboratory (PNNL) shortly after 1996.

The next modification to the network came in 1999 (change control form M-15-99-02, Appendix A) with the consolidation of monitoring under CERCLA and monitoring performed under DOE's *General Environmental Protection Program* (DOE Order 5400.1). The change control form was issued to formally document changes made to M-15-96-06, as well as changes to the monitoring network as a result of well decommissioning in the 100-F Area. The change control form was issued after the release of the sampling and analysis plan for the 100-FR-3 Operable Unit (PNNL-13327). As surface cleanup progressed, several wells were identified as impediments to excavation. The cleanup contractor, Bechtel Hanford, Inc., worked with PNNL to accommodate the 100-FR-3 Operable Unit monitoring objectives by minimizing decommissioning of wells while simultaneously meeting cleanup goals.

The last change to the monitoring network was completed in 2001. This last change control form (M-15-01-06, Appendix A) documented removal of a non-functioning well from the 100-FR-3 monitoring network, formally integrated waste control planning (DOE/RL-2000-41), and reduced the frequency of strontium-90 analysis in well 199-F5-1 from quarterly to annually.

1.3 Data Quality Objectives

Beginning in fiscal year 2003 (FY03), PNNL conducted a data quality objective (DQO) planning process for the 100-BC-5 and 100-FR-3 Operable Units. The results of that process are documented in *Data Quality Objectives Summary Report – Designing a Groundwater Monitoring and Assessment Network for the 100-BC-5 and 100-FR-3 Operable Units* (PNNL-14287). The DQO process is a formalized procedure outlined in EPA guidance (EPA 1994). As described in PNNL-14287, the 100-BC-5 and 100-FR-3 Operable Units DQO process established a framework to answer the following questions:

- Are representative samples of an aquifer with a fluctuating water-table elevation being obtained?
- Are the constituents monitored necessary and sufficient?
- Is the monitoring network adequate for purposes of tracking constituents that have potential human and other ecosystem impacts?
- Does the sampling frequency need to be revised for tracking plume movement?

The result of the DQO for the 100-FR-3 Operable Unit provides the basis for the revised monitoring network covered under this sampling and analysis plan. The recommendations that resulted from this process included the following items:

- Revise the boundaries of the 100-FR-3 Operable Unit to include a Groundwater Interest Area (Figure 1), or an area that was geographically connected to the current operable unit boundaries that might contain information useful in assessing the migration of groundwater contamination.
- Enhance shoreline monitoring to determine the impact of residual contaminants emanating from the 100-FR-3 Operable Unit.
- Modify the frequency of the sampling and analysis.
- Refine the constituents of concern from those that were previously monitored.

Addressing these issues is the scope of the revised groundwater monitoring network, which is covered in Chapter 2.

2.0 Revised Monitoring Network

The DQO recommendations included defining sampling boundaries, establishing a monitoring network design objective, and identifying contaminants of concern. The sampling boundaries are defined

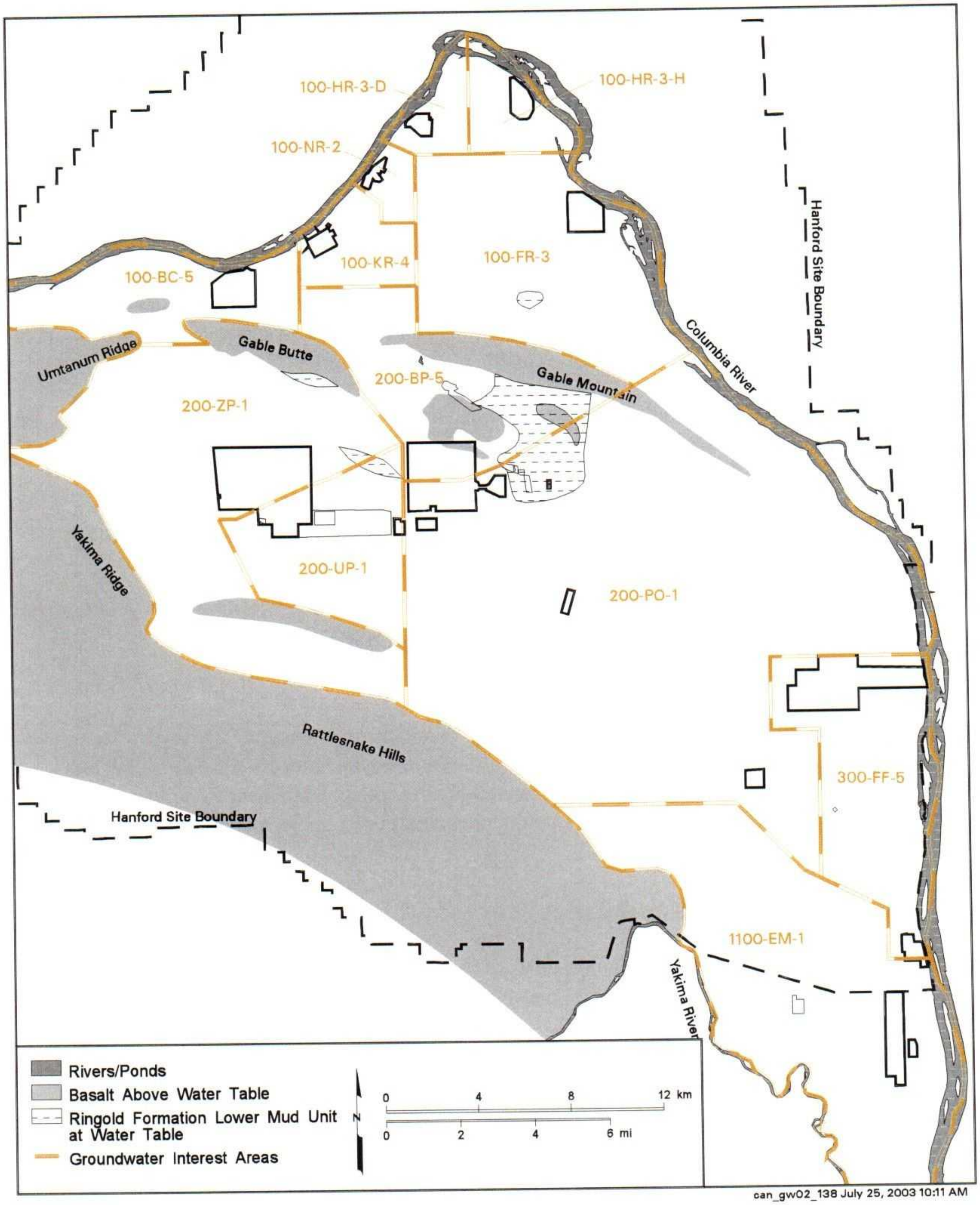


Figure 1. Groundwater Interest Area Map

as the initially created 100-FR-3 Operable Unit boundary, as well as "background zones" that extend to the south of Gable Mountain, west to the 200-BP-5, 100-KR-4, and 100-NR-2 boundaries, and north to the 100-HR-3-D and 100-HR-3-H Area boundaries. The eastern boundary is the Columbia River (Figure 2). The region outside the original 100-FR-3 boundary is termed the Groundwater Interest Area, and includes several 600 Area wells that are important for establishing background groundwater quality conditions, as well as monitoring contamination from other operable units (e.g., 200-BP-5 Operable Unit). All monitoring is performed in the unconfined aquifer and its interaction zones with the Columbia River.

The monitoring network will rely on all the existing network wells not removed during surface remediation, as well as surface seeps at the Columbia River shore line and aquifer sampling tubes (PNNL-13327) installed at the water line and in the mixing zone between groundwater and the Columbia River. Additional aquifer tubes will be installed to complete the network.

The contaminants of concern will include those constituents with concentrations already in excess of the maximum contaminant level, as well as groundwater quality indicators that will provide evidence of significant changes in groundwater conditions.

Chapter 3 presents the proposed revised field sampling plan for the 100-FR-3 Operable Unit. Chapter 4 presents the Quality Assurance Project Plan

3.0 Field Sampling Plan

The objective of the field sampling plan is to clearly identify project sampling and analysis activities. The field sampling plan uses the sampling design identified in the DQO process (PNNL-14287) and presents this design using primarily figures and tables, whenever possible, to identify sampling locations, the total number of samples to be collected, sampling procedures to be implemented, and the specific constituents of concern to be analyzed.

3.1 Sampling Locations and Frequency

The groundwater wells, seeps, and aquifer tubes to be sampled in support of the 100-FR-3 Operable Unit are listed in Table 1, and are shown in Figures 2 and 3. Samples are to be collected in accordance with the procedures listed in Section 3.4.

The monitoring network established during the work plan (DOE/RL-91-53) stage and later was sampled quarterly, semiannually, annually, and biennially depending on the well and the constituents to be monitored. The water table is influenced by river stage, which is high in the late spring and early summer, and low in the fall.

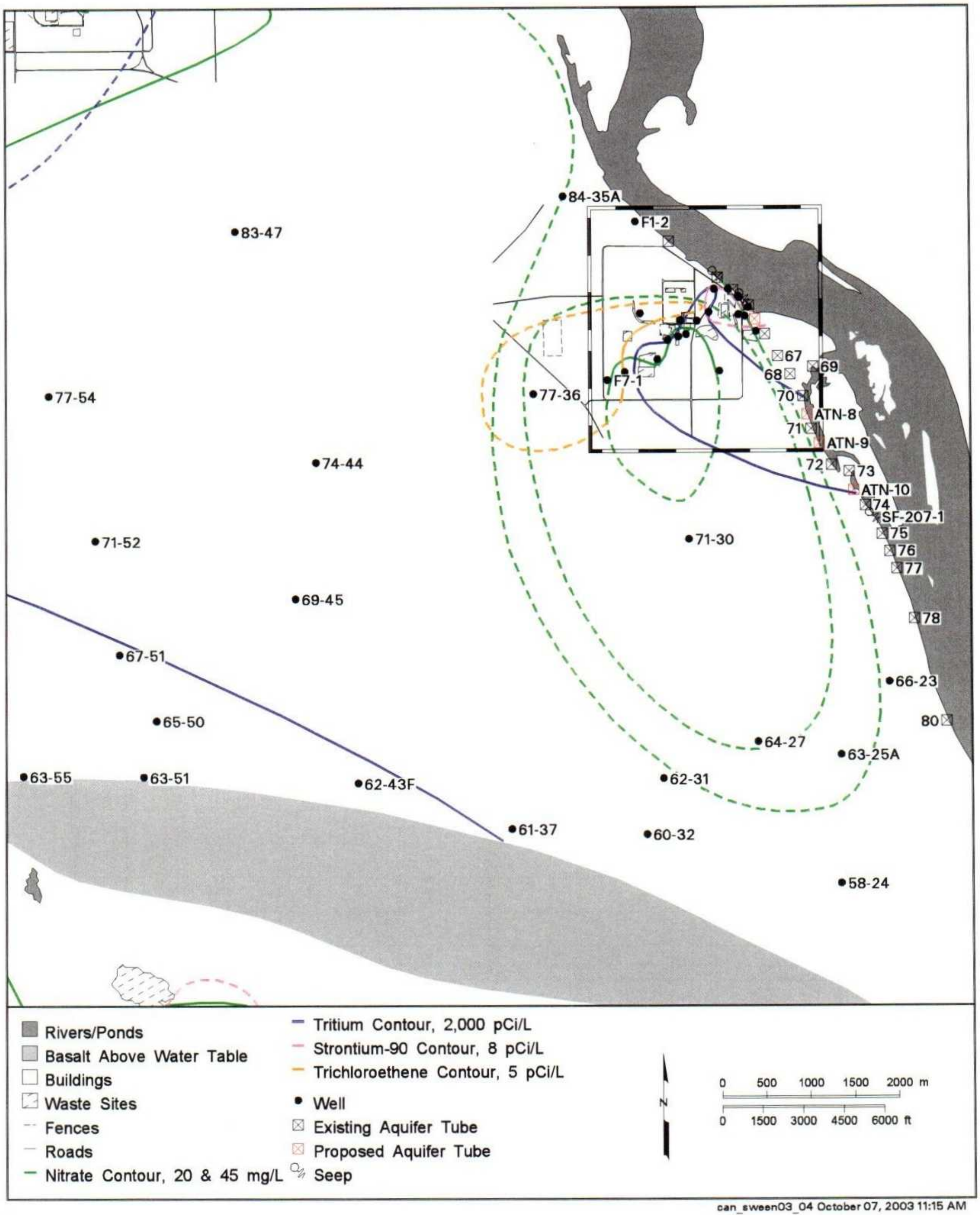


Figure 2. Sampling Boundaries and Monitoring Network for the 100-FR-3 Operable Unit Showing Wells, Seeps, and Aquifer Tubes (See Figure 3 for enlargement of area inside box.)

Table 1. Groundwater Well Sampling Matrix

Hanford Well ID	Well Number	Alkalinity	Anions	Alpha	Cr6+	TCE	ICP	Sr-90	Tritium
A4586	199-F1-2	BO	BO				BO		
A4587	199-F5-1	A	A+	BE			A	BE	A
A4589	199-F5-3	A	A+	BO				A	A
A4590	199-F5-4	A	A+	BO		BO	A		A
A4591	199-F5-42	BO	BO+	BO			BO	BO	BO
A4592	199-F5-43A	BE	BE+	BE			BE	E	BE
A4593	199-F5-43B†	BO	BO+	BO			BO	BO	BO
A4594	199-F5-44	BE	BE+	BE			BE	BE	BE
A4595	199-F5-45	BO	BO+	BO			BO	BO	BO
A4596	199-F5-46	BE	BE+	BE	BE		BE	BE	A
A4597	199-F5-47	A	A+	BE		BE	A		A
A4598	199-F5-48	BO	BO+	BO			BO		BO
A4600	199-F5-6	BE	BE+	BE			BE	BE	BE
A4602	199-F6-1	BO	BO	BO			BO	BO	BO
A4603	199-F7-1	BE	BE			BE	BE		BE
A4604	199-F7-2	BE	BE+				BE		BE
A4605	199-F7-3	BE	BE+	BE		BE	BE		BE
A4607	199-F8-2	BO	BO+	BO			BO		BO
A4608	199-F8-3	BO	BO+	A		BO	BO		A
A4609	199-F8-4	BE	BE+	A			BE		BE
A5275	699-58-24	BE	BE+				BE		
A5279	699-60-32	BO	BO+				BO		
A5283	699-61-37	BE	BE+				BE		
A5287	699-62-31	BE	BE+				BE		
A8944	699-62-43F	A	A						A
A5289	699-63-25A	BO	BO				BO		
A5290	699-63-51	BE	BE+				BE		A
A5291	699-63-55	BO	BO+				BO		A
A5295	699-64-27	BE	BE+				BE		
A5300	699-65-50	BO	BO				BO		BO
A5306	699-66-23	BE	BE+				BE		
A5312	699-67-51	BO	BO+				BO		BO
A8967	699-69-45†	BO	BO			BO	BO		

Hanford Well ID	Well Number	Alkalinity	Anions	Alpha	Cr6+	TCE	ICP	Sr-90	Tritium
A5320	699-71-30	BO	BO+				BO		
A5321	699-71-52	BE	BE			BE	BE		
A5328	699-74-44	BO	BO+			BO	BO		
A5330	699-77-36	A	A			A	A		
A5331	699-77-54	BO	BO			BO	BO		
A5341	699-83-47	BE	BE+			BE	BE		
A5342	699-84-35A†	BE	BE				BE		
Aquifer Sampling Tubes									
B8334,5,6	062-D,M,S	A	A		A*	A	A		
B8337,8,9	063-D,M,S	A	A+		A*	A	A		
B8340,1,2	064-D,M,S	A	A+		A*	A	A	A*	
B8343,4,5	065-D,M,S	A	A+		A*	A	A	A*	
B8346,7,8	066-D,M,S	A	A+		A*	A	A	A*	
B8349,50,51	067-D,M,S	A	A+		A*	A	A		
B8352,3,4	068-D,M,S	A	A+		A*	A	A		A
B8355,6,7	069-D,M,S	A	A+		A*	A	A		A
B8359.60	070-M,S	A	A+		A*	A	A		A
B8361	071-D	A	A+		A*	A	A		A
B8364,5,6	072-D,M,S	A	A+		A*	A	A		A
B8367,8,9	073-D,M,S	A	A+		A*	A	A		A
B8370,1,2	074-D,M,S	A	A+		A*	A	A		A
B8373,4,5	075-D,M,S	A	A+		A*	A	A		
B8376,7,8	076-D,M,S	A	A+		A*	A	A		
B8379,80,81	077-D,M,S	A	A+		A*	A	A		
B8382,3,4	078-D,M,S	A	A+		A*	A	A		
B8388,9,90	080-D,M,S	A	A+		A*	A	A		
New Aquifer Tube	ATN-7	A	A+		A*	A	A	A*	
New Aquifer Tube	ATN-8	A	A+		A*	A	A		A
New Aquifer Tube	ATN-9	A	A+		A*	A	A		A
New Aquifer Tube	ATN-10	A	A+		A*	A	A		A
Seep	187-1	A	A+		A	A	A		A

Hanford Well ID	Well Number	Alkalinity	Anions	Alpha	Cr6+	TCE	ICP	Sr-90	Tritium
Seep	190-4	A	A+		A	A	A		A
Seep	207-1	A	A+		A	A	A		A

A = Annually.
B = Biennially (every two years; E for wells sampled on even years [e.g., 2004]; O for wells sampled on odd years [e.g., 2005]).
D = Deep.
M = Moderate.
S = Shallow.

+ indicates that NO_3 analysis is included.
* indicates that the well or aquifer tube will be sampled quarterly for one fiscal year.
† indicates the well completion is deeper into the unconfined aquifer than the remaining network wells.

For 699-xx-yy wells, xx and yy designate Hanford north and west coordinates in thousands of feet north and west from an origin in the southeastern part of the site. All of the wells monitor the uppermost aquifer.

Sampling technicians will attempt to obtain representative sample from all tube depths, but not all will be successful for a variety of reasons including, but not limited to, the collapse or clogging of well screens or clogged sampling tube. All failed attempts at sampling wells and tubes are noted in the groundwater sampling record. Before initiating sampling at wells that have been idle for several years, well maintenance staff will perform an inspection and correct any deficiencies found.

Previously, annual and biennial sampling often coincided with the time of year when groundwater in most wells was at its lowest elevation. Groundwater will continue to be sampled at low river stage. The initiation of groundwater sampling under this sampling and analysis plan, however, will provide an opportunity to assess the season of highest contaminant concentration based on the conceptual model described in the DQO report (PNNL-14287). Selected aquifer tubes will be sampled quarterly (Table 1) for the first year to assess the variability of contaminants in groundwater near the Columbia River. The assessment may conclude with a revision of this sampling and analysis plan with a sampling schedule of near-shore monitoring wells and aquifer tubes that better captures the highest concentration, and/or the seasonal fluctuations influenced by hydrologic dynamics.

Vertical variability within the wells will be addressed by sampling with a device that can discretely identify portions of the screened interval that may have a controlling influence on contamination found in well samples. Two wells, 199-F5-3 and 199-F5-6, will be sampled using the spyder sampling accessory. This instrument is added to a pump intake to increase the percentage and volume of water obtained from the formation and filter pack while diminishing the vertical and well-bore contribution to the sample. It is designed to sample conditions within the well where stagnant water in portions of the screen well is suspected, and where flow is predominantly horizontal through the well.

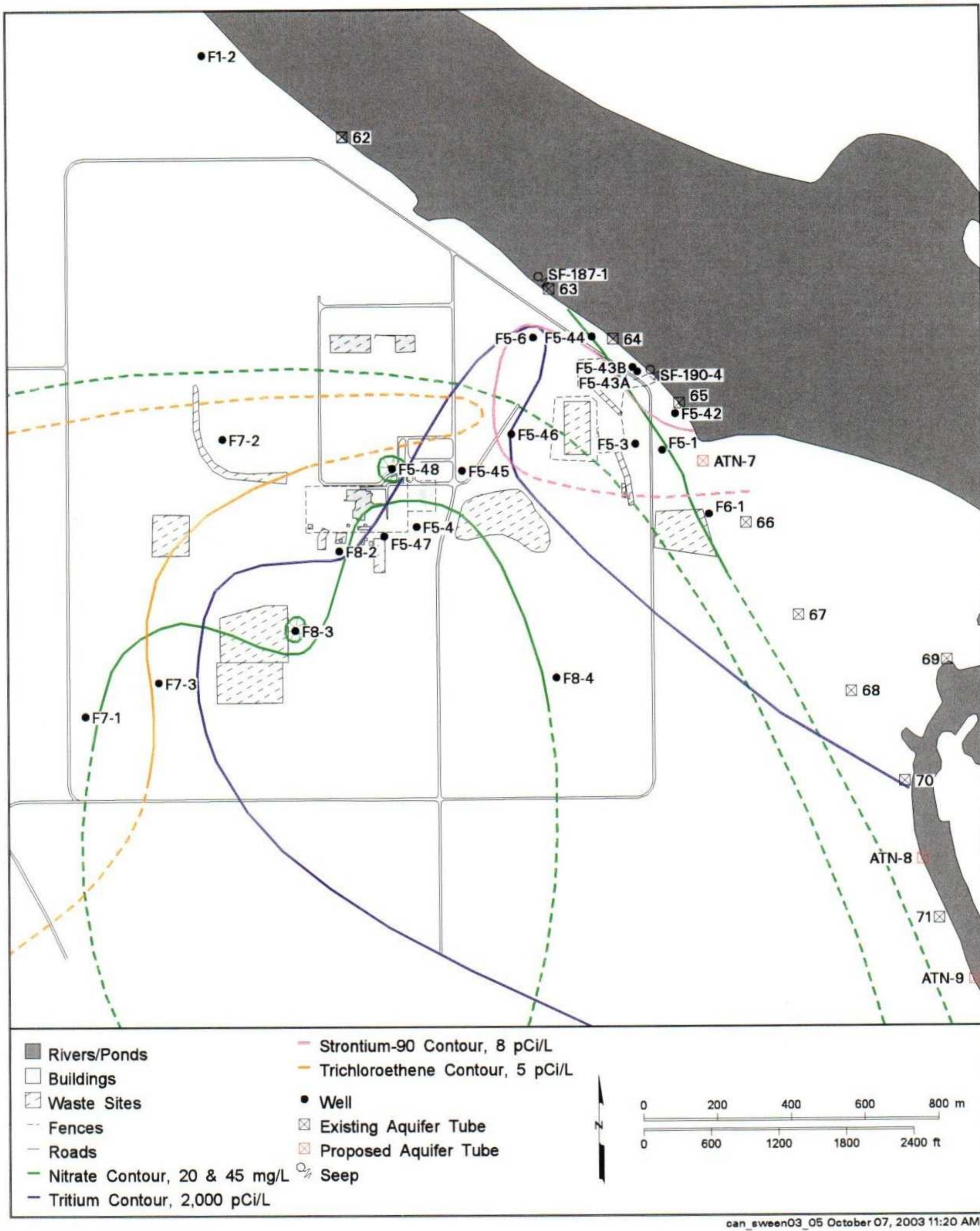


Figure 3. Monitoring Network Location Map Showing 100-F Area Wells

The device consists of a head with flexible tubing extending from the central collector (Figure 4). Angled cuts on the tube ends allow a seal against the well screen when the unit is lowered into place (Figure 4). The hydrodynamic shape minimizes disturbance to the well water and associated primary flow zones and patterns. Water enters primarily from the filter pack and the formation.

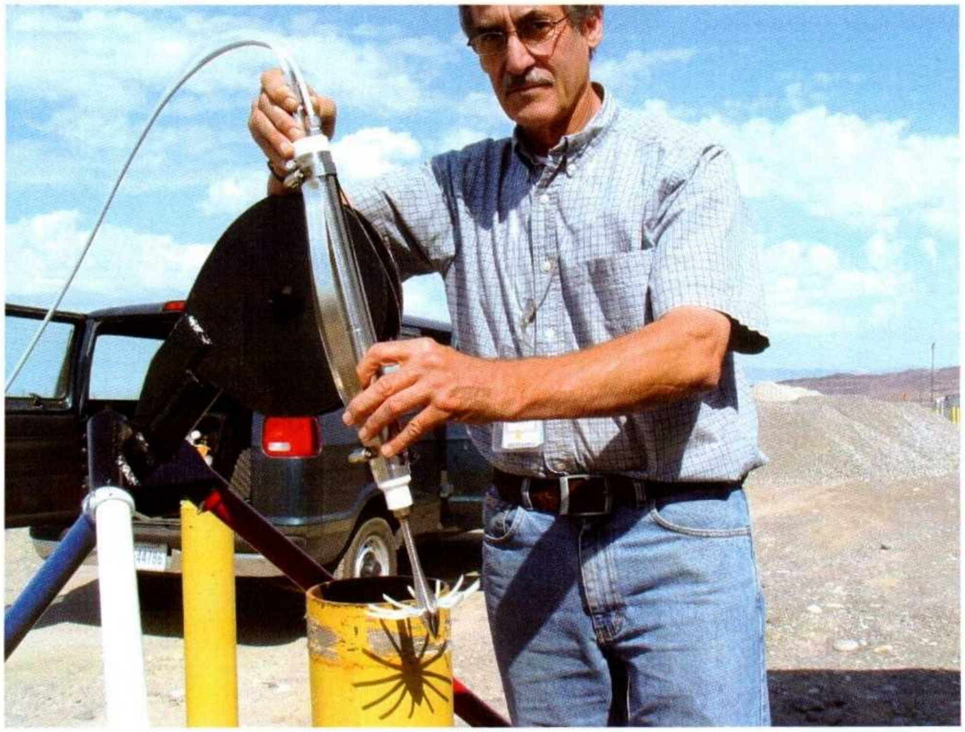


Figure 4. Spyder Sampling Accessory (displaying the sampling head)

3.2 Proposed Aquifer Sampling Tubes

Aquifer sampling tubes are installed at numerous sites along the Hanford side of the shoreline of the Columbia River. The objective for the tubes is to monitor water quality in the zone of interaction between groundwater and river water.

At each site, three tubes are installed, with screened sampling ports positioned at various depths in the aquifer. A typical installation includes one sampling port just beneath the low river stage water table; a second near the bottom of the uppermost hydrologic unit; and the third at mid-depth between the other two ports. Field conditions may result in more or fewer tubes at a particular location.

The current controlling document for the aquifer tube task is *Sampling and Analysis Plan for Aquifer Sampling Tubes* (DOE/RL-2000-59). This guidance is confined to aquifer sampling tubes used in support of CERCLA objectives. DOE/RL-2000-59 will be revised during FY 2004 to reflect the addition of new aquifer tubes and the publication of new sampling and analysis plans that list requirements specific to an operable unit. In order to foster consistency in the task, procedures and methods will be emphasized in the DOE/RL-2000-59 and tube lists, analysis suites, and frequency of sampling will be emphasized in the operable unit sampling and analysis plans.

At present, 18 aquifer-sampling tubes are installed along the Columbia River shoreline from a point upstream from the 100-F Area to the end of the Groundwater Interest Area (Figures 1 and 2). Enhancing the aquifer sampling tube network was identified as the best solution to several problems identified in the DQO report (PNNL-14287). The degree of spatial and vertical variability can be assessed more precisely with an enhanced network. Gauging the flux of contaminants entering the river is also improved through the installation of more sampling points. Four new aquifer tubes (Table 1) will provide better estimates of the boundaries of existing plumes in and/or near the 100-F Area.

The tubes will be installed at multiple depths using either Geoprobe™ equipment or a hand-held pneumatic drive hammer. The probe tips act as a port through which groundwater will be drawn. The tip is connected to the surface by a polyethylene sampling tube that has an outside diameter of 0.63 cm (0.25 in.). The tip is constructed of a 15-cm- (6-in.-) long mesh screen that has a 0.95-cm (0.375-in.) outside diameter and a pore opening of 0.0145 cm (0.0057 in.) (BHI-01153).

The tubes are installed in steel pipe that is driven into the subsurface either by direct pressure or by repetitive blows. The direct pressure method is a variation of a cone penetrometer method used widely in the environmental monitoring industry. The sampling port is driven into the formation by loading a steel pipe (rod) with weight. The pneumatic hammer drives the tip forward with a series of short blows to the steel pipe from an air-driven hammer. In both instances, the tip, which contains the sampling port, is abandoned in the formation that collapses around the device as the steel pipe is slowly withdrawn using a set of hydraulic jacks. The probe reaches the target depth by attaching additional pipe lengths.

The baseline procedure for routine monitoring at aquifer tube sites involves the following:

- Withdraw water from each available tube and measure the sample's specific conductance.

- Collect additional samples for analysis of constituents of interest from the tube that is most representative of groundwater.

- Under the current sampling and analysis plan (DOE/RL-2000-59), if the water from tubes has a specific conductance less than 160 μS/cm, the site is considered not representative of groundwater and no samples are collected for constituent of interest analyses.

New aquifer tubes will be installed during the fall of 2003.

3.3 Constituents of Concern

Constituents of concern refer to contaminants that have been recognized as posing significant risk to human health and the environment. Many of these contaminants are listed as hazardous substances in various state and federal regulations. The concentration of these contaminants will determine whether they continue to require additional groundwater sampling from wells, seeps, or aquifer tubes. Discussion of the future risk by eliminating groundwater monitoring of these constituents will occur in the context of negotiations between the U.S. Department of Energy (DOE) and EPA.

Groundwater contamination by radiological and chemical constituents has lessened since the CERCLA management began in the 100-F Area as a result of source remediation and natural decay or attenuation. Of the current constituents of concern, only nitrate, strontium-90, tritium, and trichloroethene continue to exhibit concentrations above the drinking water standards in groundwater monitoring wells, seeps, and aquifer sampling tubes. Hexavalent chromium and uranium concentrations have dropped below regulatory thresholds. These analytes may eventually be dropped from the sampling schedule as this groundwater sampling and analysis plan evolves to meet site conditions.

The analytical groups identified in Table 1 constitute the constituents of concern for the 100-F Area, as well as provide needed groundwater quality information for assessing analytical results. To that end, a screening parameter will be used to assess radiological contamination in the 100-FR-3 Operable Unit. Gross alpha will be used to identify potentially elevated radionuclide concentrations (e.g., uranium).

3.4 Water-Level Monitoring

Water levels in the groundwater system are monitored on the Hanford Site primarily to help determine the direction and rate of groundwater flow. This information is used to interpret observed contaminant plume movement and to predict future movement. The water-level information can also be used to identify recharge and discharge areas, assess the interaction between groundwater and surface water, assess interaction between aquifers, calibrate groundwater flow models, assess the impact of liquid effluent disposal practices on groundwater flow, and optimize monitoring networks.

Static water levels are measured in the monitoring well prior to sampling, and a minimum of two consistent measurements are taken to confirm precision of the measurement. In addition, the Hanford Groundwater Monitoring Project measures water levels across the Hanford Site annually to construct a site-wide water-table map. A list of wells used for water-level measurements, criteria for their selection, hydrogeologic units monitored, and descriptions of the techniques used to collect the data are provided in *Water-Level Monitoring Plan for the Hanford Groundwater Monitoring Project* (PNNL-13021). The wells identified in PNNL-13021 will be used for annual measurements for the 100-FR-3 Operable Unit. Samplers measure depth to groundwater according to Duratek's procedure SP 3-3 (DFSNW-SSPM-001). The depth to groundwater is subtracted from the elevation of a reference point (usually top of casing) to obtain the water-level elevation.

3.5 Sampling and Analysis Procedures

Groundwater monitoring for the 100-FR-3 Operable Unit is part of the Hanford Groundwater Monitoring Project. This section describes the project's protocols for sample collection and analysis. Project staff schedule sampling and initiate paperwork. The project uses subcontractors for sample collection, shipping, and analysis.

3.5.1 Scheduling Groundwater Sampling

The Hanford Groundwater Monitoring Project's procedures provide direction for scheduling and document production. Many Hanford Site wells are sampled for multiple objectives and requirements, e.g., CERCLA, *Atomic Energy Act of 1954*. Following the scheduling procedure helps manage the overlap, eliminating redundant sampling and meeting the needs of each sampling objective. The scheduling procedure includes the following steps:

- Each fiscal year, project scientists provide well lists, constituent lists, and sampling frequency. Each month, project scientists review the sampling schedule for the following month. Changes are requested via change request forms and approved by the sampling and analysis task lead and the monitoring project manager.

- Project staff track sampling and analysis through an electronic schedule database stored on a server at PNNL. Quality control samples also are managed through this database. A scheduling program generates unique sample numbers and a special user interface generates sample authorization forms, field service reports, groundwater sample reports, chain of custody forms, and sample container labels.

- Sampling and analysis staff verify that such information as well name, sample numbers, bottle sizes, or preservatives are indicated properly on the paperwork, which is transmitted to the sampling subcontractor. Staff complete a checklist to document that the paperwork was generated correctly.

- At the end of each month, project staff use the schedule database to determine if any wells were not sampled as scheduled. If the wells or sampling pumps require maintenance, they are rescheduled following repair. If a well can no longer be sampled, the sampling is cancelled and the reason is recorded in the database.

3.5.2 Chain of Custody

The sampling subcontractor uses chain of custody forms to document the integrity of groundwater samples from the time of collection through data reporting. The forms are generated during scheduling (see Section 3.5.1) and managed through subcontractor procedure SP 1-1 (DFSNW-SSPM-001).

3.5.3 Sample Collection

The procedure for groundwater sampling is described in procedure SP 3-1 (DFSNW-SSPM-001). Samples generally are collected after three casing volumes of water have been purged from the well or after field parameters (pH, temperature, specific conductance, and turbidity) have stabilized (i.e., after two consecutive measurements are within 0.2 units pH, 0.2°C for temperature, 10% for specific conductance, and turbidity <5 NTU). For routine groundwater samples, preservatives are added to the collection bottles before their use in the field according to procedure SP 2-1 (DFSNW-SSPM-001). Samples to be analyzed for metals are usually filtered in the field so that results represent dissolved metals.

3.5.4 Analytical Protocols

Procedures for field measurements are specified in subcontractor's procedures (DFSNW-SSPM-001) SP 6-2 (turbidity), SP 6-3 (pH), SP 6-5 (specific conductance), and SP 6-7 (temperature). Each instrument is assigned a unique number that is tracked on field documentation and is calibrated and controlled according to procedure SP 6-1 (DFSNW-SSPM-001). Additional calibration and use instructions are specified in the instrument user's manuals.

Laboratory analytical methods are specified in contracts with the laboratories, and most are standard methods from *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* (EPA 1986a). Alternative procedures meet the guidelines of EPA (1986b, Chapter 10). Analytical methods are described in Chapter 8 of PNNL-13080.

3.5.5 Management of Waste

Waste generated by sampling activities will be managed consistent with an established waste management plan, and the requirements of procedure SP 2-2 (DFSNW-SSPM-001), or equivalent. Purgewater determinations and purgewater handling for the individual wells covered in this sampling plan will be completed and managed in accordance with the *Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington.*[1]

Unused samples and associated waste for the analysis will be dispositioned in accordance with the laboratory contract and agreements. The approval of the Hanford Groundwater Monitoring Project is required before returning unused sampled or waste from offsite laboratories.

4.0 Quality Assurance Plan

Environmental management programs require the implementation of quality control (QC) and quality assurance procedures to maintain the integrity of analytical results used in risk assessment. PNNL follows state and federal guidance to manage data quality from the point of sample acquisition, through the analytical process and interpretation, to the final reporting.

4.1 Quality Control

The Hanford Groundwater Monitoring Project's QC program is designed to assess and enhance the reliability and validity of groundwater data. This is accomplished through evaluating the results of QC samples, conducting audits, and validating groundwater data. This section describes the QC program for the entire groundwater project, which includes the 100-FR-3 Operable Unit.

[1] Letter No. 90-ERB-040 from U.S. Department of Energy, Richland Operations Office to P. T. Day, U.S. Environmental Protection Agency, and T. L. Nord, Washington State Department of Ecology, *Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington*, dated July 19, 1990.

The QC practices of the groundwater project are based on guidance from EPA (EPA 1979, EPA 1986a, EPA 1986b, EPA 1986c). Accuracy, precision, and detection are the primary parameters used to assess data quality (Mitchell et al. 1985). Data for these parameters is obtained from two categories of QC samples: those that provide checks on field and laboratory activities (field QC) and those that monitor laboratory performance (laboratory QC). Table 2 summarizes the types of samples in each category along with the sample frequencies and characteristics evaluated.

Table 2. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
	Field QC	
Full trip blank	Contamination from containers or transportation	1 per 20 well trips
Field transfer blank	Airborne contamination from the sampling site	1 each day VOC samples are collected
Equipment blank	Contamination from non-dedicated sampling equipment	1 per 10 well trips or as needed[(a)]
Duplicate samples	Reproducibility	1 per 20 well trips
	Laboratory QC	
Method blank	Laboratory contamination	1 per batch
Lab duplicates	Laboratory reproducibility	Method/contract specific[(b)]
Matrix spike	Matrix effects and laboratory accuracy	Method/contract specific[(b)]
Matrix spike duplicate	Laboratory reproducibility and accuracy	Method/contract specific[(b)]
Surrogates	Recovery/yield	Method/contract specific[(b)]
Laboratory control sample	Accuracy	1 per batch
Double-blind standards	Accuracy and precision	Varies by constituent[(c)]

(a) When a new type of non-dedicated sampling equipment is used, an equipment blank should be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the equipment's decontamination procedure.

(b) If called for by the analytical method, duplicates, matrix spikes, and matrix spike duplicates are typically analyzed at a frequency of 1 per 20 samples. Surrogates are routinely included in every sample for most gas chromatographic methods.

(c) Double blind standards containing known concentrations of selected analytes are typically submitted in triplicate or quadruplicate on a quarterly, semi-annual, or annual basis.

QC data are evaluated based on established acceptance criteria for each QC sample type. For field and method blanks, the acceptance limit is generally two times the instrument detection limit (metals), method detection limit (other chemical parameters), or minimum detectable activity (radiochemistry parameters). However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, and phthalate esters, the limit is five times the method detection limit. Groundwater samples that are associated (i.e., collected on the same date and analyzed by the same method) with out-of-limit field blanks are flagged with a Q in the database to indicate a potential contamination problem.

Field duplicates must agree within 20%, as measured by the relative percent difference, to be acceptable. Only those field duplicates with at least one result greater than five times the appropriate detection limit are evaluated. Unacceptable field duplicate results are also flagged with a Q in the database.

For chemical analyses, the acceptance criteria for laboratory duplicates, matrix spikes, matrix spike duplicates, surrogates, and laboratory control samples are generally derived from historical data at the laboratories in accordance with EPA (1986a). Typical acceptance limits are within 25% of the expected values, although the limits may vary considerably with the method and analyte. For radiological analyses, the acceptance limits for laboratory QC samples are specified in the laboratory contract. Current values for laboratory duplicates, matrix spikes, and laboratory control samples are 20% relative percent difference, 60-140%, and 70-130%, respectively. These values are subject to change if the contract is modified or replaced.

Table 3 lists the acceptable recovery limits for the double-blind standards. These samples are prepared by spiking background well water (currently wells 699-19-88 and 699-49-100C) with known concentrations of constituents of interest. Spiking concentrations range from the detection limit to the upper limit of concentration determined in groundwater on the Hanford Site. Double-blind standard results that are outside the acceptance limits are investigated and appropriate actions are taken if necessary.

Table 3. Recovery Limits for Double-Blind Standards

Constituent	Frequency	Recovery Limits	Precision Limits (relative percent difference)
Gross alpha[(a)]	Quarterly	70–130%	20%
Nitrate	Quarterly	75–125%	25%
Specific conductance	Quarterly	75–125%	25%
Strontium-90	Semi-Annually	70–130%	20%
Trichloroethene	Quarterly	75–125%	25%
Tritium	Annually	70–130%	20%
(a) Gross alpha standards will be spiked with plutonium-239.			

Holding time is the elapsed time period between sample collection and analysis. Exceeding recommended holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Recommended holding times depend on the analytical method, and are listed in the annual groundwater monitoring report (e.g., Table B.8 of PNNL-14287). Data associated with exceeded holding times are flagged with an "H" in the Hanford Environmental Information System (HEIS 1994).

Additional QC measures include laboratory audits and participation in nationally-based performance evaluation studies. The contract laboratories participate in national studies such as the EPA-sanctioned Water Pollution and Water Supply Performance Evaluation studies. The groundwater project periodically audits the analytical laboratories to identify and solve quality problems, or to prevent such problems. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report.

4.2 Groundwater Data Validation Process

The groundwater project's data validation process provides requirements and guidance for validation of groundwater data that are routinely collected as part of the groundwater project. Validation is a systematic process of reviewing data against a set of criteria to determine whether the data are acceptable for their intended use. This process applies to groundwater data that have been verified (see Section 4.3.1) and loaded into HEIS. The outcome of the activities described below is an electronic data set with suspect or erroneous data corrected or flagged. Groundwater monitoring project staff document the validation process quarterly by signing a checklist, which is stored in the project file.

Responsibilities for data validation are divided among project staff. Each RCRA unit or geographic region is assigned to a project scientist, who is familiar with the hydrogeologic conditions of that site. The data validation process includes the following elements.

- **Generation of data reports.** Twice each month, data management staff provide tables of newly loaded data to project scientists for evaluation (biweekly reports). Also, after laboratory results from a reporting quarter have been loaded into HEIS, staff produce tables of water-level data and analytical data for wells sampled within that quarter (quarterly reports). The quarterly data reports include any data flags added during the quality control evaluation or as a result of prior data review.

- **Project scientist evaluation.** As soon as practical after receiving biweekly reports, project scientists review the data to identify changes in groundwater quality or potential data errors. Evaluation techniques include comparing key constituents to historical trends or spatial patterns. Other data checks may include comparison of general parameters to their specific counterparts (e.g., conductivity to ions) and calculation of charge balances. Project scientists request data reviews if appropriate (see Section 4.3.2). If necessary, the lab may be asked to check calculations or re-analyze the sample, or the well may be re-sampled. After receiving quarterly reports, project scientists review sampling summary tables to determine whether network wells were sampled and analyzed as scheduled. If not, they work with other project staff to resolve the problem. Project scientists also review quarterly reports of analytical and water-level data using the same techniques as for biweekly reports. Unlike the biweekly reports, the quarterly reports usually include a full data set (i.e., all the data from the wells sampled during the previous quarter have been received and loaded into HEIS).

- Staff report results of quality control evaluations informally to project staff, DOE Richland Operations Office, and Washington State Department of Ecology each quarter. Results for each fiscal year are described in the annual groundwater monitoring report.

4.3 Data Management, Evaluation, and Reporting

This section describes how the groundwater project loads analytical and field data into HEIS and how suspect data are reviewed.

4.3.1 Loading and Verifying Data

The contract laboratories report analytical results electronically and in hard copy. The electronic results are loaded into HEIS. Hard-copy data reports and field records are considered to be the record copies and are stored at PNNL. Project staff perform an array of computer checks on the electronic file for formatting, allowed values, data flagging (qualifiers), and completeness. Verification of the hard copy results includes checks for (1) completeness, (2) notes on condition of samples upon receipt by the laboratory, (3) notes on problems that arose during the analysis of the samples, and (4) correct reporting of results. If data are incomplete or deficient, staff work with the laboratory to get the problems corrected. Notes on condition of samples or problems during analysis may be used to support data reviews (see Section 4.3.2).

Field data, such as specific conductance, pH, temperature, turbidity, and depth to water, are recorded on field records. Data management staff enter these into HEIS manually through data-entry screens, verify each value against the hard copy, and initial each value on the hard copy.

4.3.2 Data Review

The Hanford Groundwater Monitoring Project's data review procedure describes the process for reviewing specific groundwater analytical data or field measurements when results are in question. Groundwater staff document the process on a "Request for Data Review" (RDR) form and results are used to flag the data appropriately in HEIS. Various staff may initiate an RDR, e.g., project scientists, data managers, or quality control staff. The data review process includes the following steps:

- The initiator fills out required information on the RDR form, such as sample number, constituent, and reason for the request (e.g., "result is two orders of magnitude greater than historical results and disagrees with duplicate."). The initiator recommends an action, such as a data re-check, sample re-analysis, well re-sampling, or simply flagging the data as suspect in HEIS.

- The data review coordinator determines that the RDR does not duplicate a previously submitted RDR, then assigns a unique RDR number and records it on the form. A temporary flag is assigned to the data in HEIS, indicating the data are undergoing review ("F" flag).

- If laboratory action is required, the data review coordinator records the laboratory's response on the RDR form. Other documentation also may be relevant, such as chain-of-custody forms, field records, calibration logs, or chemist's sheets.

- A project scientist assigned to reviewing RDRs determines and records the appropriate response and action on the RDR form, including changes to be made to the data flags in HEIS. Actions may include updating HEIS with corrected data or result of re-analysis, flagging existing data (e.g., R for reject, Y for suspect, G for good), and/or adding comments. Data management updates the temporary "F" flag to the final flag in HEIS.

- The data review coordinator signs the RDR form to indicate its closure.

- If an RDR is filed on data that are not "owned" by the groundwater project, the data review coordinator forwards a copy of the partially filled form to the appropriate contact for their action. The RDR is then closed.

4.3.3 Reporting

Chemistry and water-level data are reviewed after each sampling event and are available in HEIS. Any unusual results for the 100-FR-3 Operable Unit will be summarized in letter reports or informal reports to EPA (e.g., quarterly reports via e-mail). Formal, interpretive reports are issued annually in March (e.g., PNNL-14287).

4.3.4 Change Control

The approach to making changes in 100-FR-3 Operable Unit monitoring activities, associated documents, and approval requirements are listed in Table 4.

Table 4. Change Control for Groundwater Monitoring in the 100-FR-3 Operable Unit

Type of Change	Action	Documentation
Adding constituents, wells, or increasing sampling frequency.	Project management approval; notify regulator if appropriate.	Project's schedule tracking system.
Changes to supporting constituents (not contaminants of concern).		
Deleting contaminants of concern, wells, or reducing frequency.	Obtain regulator approval.	Letter or signed meeting minutes; project's schedule tracking system.
Unavoidable changes (e.g., dry wells; delayed samples, one-time missed samples due to broken pump, lost bottle, etc.).	Notify regulator.	
Revision to sampling and analysis plan.	Revise plan; obtain regulator approval; distribute plan.	Sampling and analysis plan with signed concurrence page.

5.0 Health and Safety

All field operations will be performed consistent with PNNL health and safety requirements and the requirements of accepted PNNL laboratory procedures, as implemented via subcontracts and work orders.

Where necessary, a work planning packages will include, as appropriate, a job hazard analysis, and/or a site-specific health and safety plan, and applicable radiological permits.

The sampling procedures and associated activities will implement as low as reasonably achievable practices to minimize the radiation exposure to the sampling team, consistent with the requirements outlined in accepted PNNL procedures.

6.0 References

Atomic Energy Act of 1954, as amended, Ch. 1073, 68 Stat. 919, 42 USC 2001 et seq.

BHI-01153. 1998. *Aquifer Sampling Tube Completion Report: 100 Areas and Hanford Townsite Shorelines*. RE Peterson, JV Borghese, and DB Erb, Bechtel Hanford Inc., Richland, Washington.

Brown, DJ and JR Raymond. 1962. *Hanford Experience in the Radiological Monitoring of Ground Water*. HW-SA-2566, General Electric Company, Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act, as amended, Public Law 96-510, 94 Stat 2767, 42 USC 9601 et seq.

DFSNW-SSPM-001. 2003. *Sampling Services Procedure Manual*. Duratek Federal Services Northwest, Richland, Washington.

DOE Order 5400.1. "General Environmental Protection Program."

DOE/RL-90-08, Rev. 0. 1992. *Remedial Investigation/Feasibility Work Plan for the 100-BC-5 Operable Unit, Hanford Site, Richland Washington*. U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-91-53, Rev. 0. 1992. *Remedial Investigation/Feasibility Work Plan for the 100-FR-3 Operable Unit, Hanford Site, Richland Washington*. U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-93-83, Rev. 0. 1994. *Limited Field Investigation Report for the 100-FR-3 Operable Unit*. U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2000-41, Rev.0. 2000. *Interim Action Waste Management Plan for the 100-FR-3 Operable Unit.* U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology – Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy. 1998. *Hanford Federal Facility Agreement and Consent Order.* Document No. 89-10, Rev. 5 (The Tri-Party Agreement), Olympia, Washington.

EPA. 1979. *Handbook for Analytical Quality Control in Water and Wastewater Laboratories.* EPA-600/4-79-019, U.S. Environmental Protection Agency, Cincinnati, Ohio.

EPA. 1986a. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846, Third Edition.* Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available online at: http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm

EPA. 1986b. *Quality Assurance Manual for Waste Management Branch Investigations.* EPA 910/9-86-00, U.S. Environmental Protection Agency Region 10, Washington, D.C.

EPA. 1986c. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document.* OSWER-9950.1, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1994. *Guidance for the Data Quality Objectives Process.* EPA QA/G-4, U.S. Environmental Protection Agency, Washington, D.C.

HEIS. 1994. *Hanford Environmental Information System.* Environmental Information Systems Department, Fluor Hanford, Inc., Richland, Washington.

Mitchell, WJ, RC Rhodes, and FF McElroy. 1985. "Determination of Measurement Data Quality and Establishment of Achievable Goals for Environmental Measurements." *Quality Assurance for Environmental Measurements*, ASTM STP 867.

PNNL-13021. 1999. *Water-Level Monitoring Plan for the Hanford Groundwater Monitoring Project.* JP McDonald, MA Chamness, and DR Newcomer, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13080. 2000. *Hanford Site Groundwater Monitoring: Setting, Sources, and Methods.* MJ Hartman, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13327. 2000. *Groundwater Sampling and Analysis Plan for the 100-FR-3 Operable Unit.* MD Sweeney, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-14287. 2003. *Data Quality Objectives Summary Report - Designing a Groundwater Monitoring and Assessment Network for the 100-BC-5 and 100-FR-3 Operable Units.* MD Sweeney and CJ Chou, Pacific Northwest National Laboratory, Richland, Washington.

Appendix A

Appendix A

This appendix contains the change control forms that regulate the work done at the 100-F-5 Operable Unit:

- Change Control Form 39 – November 18, 1992, page A.2 through A.6.
- Change Control Form M-15-96-06 – July 31, 1996, pages A.7 through A.10.
- Change Control Form M-15-99-02 – July 14, 1999, page A.11 through A.13.
- Change Control Form M-15-01-06 – January 15, 2002, page A.14 through A.16.

Control Number	100 NPL Agreement/Change Control Form	Date Submitted
39	__ Change XX Agreement __ Information Operable Unit(s) 100-FR-3	11/18/92 Date Approved

Document Number & Title:	Date Document Last Issued
100-FR-3 Groundwater Operable Unit Monitoring Network	First Issue

Originator	Phone
J. W. Roberts	(509) 376-5164

Summary Description

100-FR-3 Groundwater Network

Justification and Impact of Change

R. P. Henckel [signature] — 11-24-92
WHC 100 Area Rem. Inves. Mgr. — Date

E. D. Goller Eric Goller — 11-24-92
DOE Unit Manager — Date

P. S. Innis Pamela S. Innis — 12-1-92
Lead Regulatory Unit Manager — Date

Per Action Plan for Implementation of the Hanford Consent Order and Compliance Agreement Section 9.3

100-FR-3 OPERABLE UNIT
GROUNDWATER MONITORING NETWORK

* see attached expanded List (a existing wells)

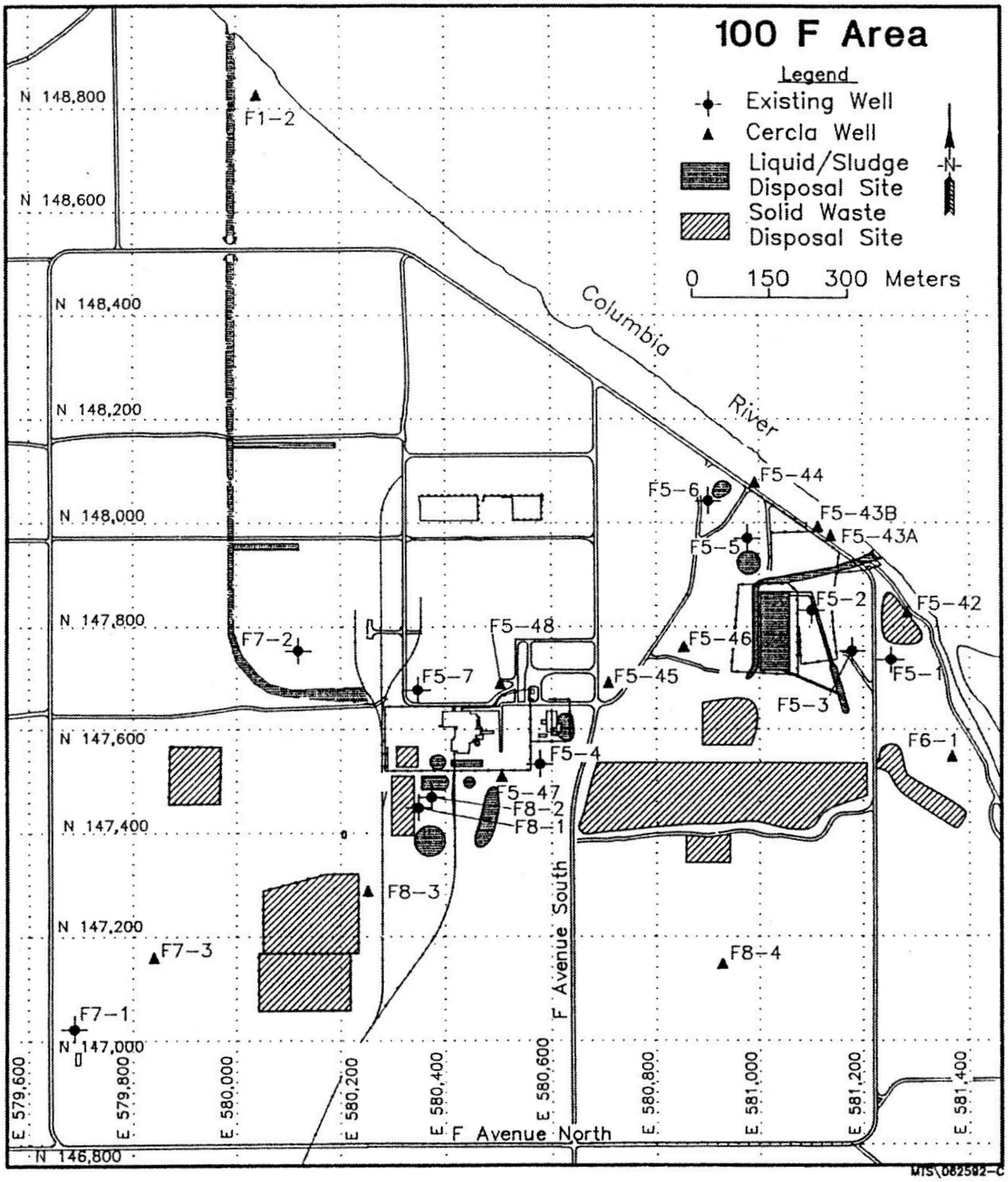
The 100-FR-3 groundwater monitoring network consists of 13 wells, 12 of which were drilled for the CERCLA program in 1992 and 1 existing well determined to be fit for use. Specific well data and purpose are shown in Table 1 below. Groundwater samples will be collected on a quarterly basis beginning in December 1992.

The first two rounds of groundwater samples will be analyzed for the full suite of CERCLA TCL organics, TAL inorganics, and selected radionuclides and other general chemical parameters. The results of these analyses will be used to prepare a reduced list of analytes for subsequent sampling rounds.

The specific analytes and analytical methods are presented in the QAPjP (Appendix A) of the 100-FR-3 Work Plan (DOE/RL-91-53). Well locations are shown on the attached map.

Table 1. 100-FR-3 Well Data

WELL	WELL TYPE	PURPOSE
199-F1-2	CERCLA	Between the Lewis Canal and the Columbia River.
199-F5-42	CERCLA	Monitors the 116-F-14 retention basin.
199-F5-43A	CERCLA	Monitors the 116-F-14 retention basin.
199-F7-2	Existing	Monitors the Lewis Canal.
199-F5-44	CERCLA	Monitors the 116-F-13 site.
199-F5-45	CERCLA	Downgradient of the central reactor area.
199-F5-46	CERCLA	Monitors area between the F reactor and the 116-F-14 retention basin.
199-F5-47	CERCLA	Monitors the 116-F-3, 116-F-10, and 116-F-6 sites.
199-F5-48	CERCLA	Monitors the central reactor area.
199-F6-1	CERCLA	Monitors the 116-F-2 trench.
199-F7-3	CERCLA	Monitors area between the Biology Sheep Lot and the 118-F-1 solid waste burial ground.
199-F8-3	CERCLA	Monitors the 118-F-1 solid waste burial ground.
199-F8-4	CERCLA	Monitors contaminant migration south of the reactor site.


100 F Area
Legend
Existing Well
Cercla Well
Liquid/Sludge Disposal Site
Solid Waste Disposal Site
0 150 300 Meters
N
Columbia River
N 148,800
N 148,600
N 148,400
N 148,200
N 148,000
N 147,800
N 147,600
N 147,400
N 147,200
N 147,000
N 146,800
E 579,600
E 579,800
E 580,000
E 580,200
E 580,400
E 580,600
E 580,800
E 581,000
E 581,200
E 581,400
F Avenue North
F Avenue South
F1-2
F5-44
F5-6
F5-43B
F5-43A
F5-5
F5-2
F5-42
F5-48
F5-46
F7-2
F5-7
F5-45
F5-1
F5-3
F6-1
F5-4
F5-47
F8-2
F8-1
F8-3
F7-3
F8-4
F7-1
MIS\082592-C

100-FR-3 OPERABLE UNIT
GROUNDWATER MONITORING NETWORK (WESTINGHOUSE)

* Note: It appears that NPL #39 was adjusted by adding 9 additional existing wells to the Network

The 100-FR-3 groundwater monitoring network consists of 22 wells, 12 of which were drilled for the CERCLA program in 1992 and 10 existing well determined to be fit for use. Specific well data and purpose are shown in Table 1 below. Groundwater samples will be collected on a quarterly basis beginning in December 1992.

The first two rounds of groundwater samples will be analyzed for the full suite of CERCLA TCL organics, TAL inorganics, and selected radionuclides and other general chemical parameters. The results of these analyses will be used to prepare a reduced list of analytes for subsequent sampling rounds.

The specific analytes and analytical methods are presented in the QAPjP (Appendix A) of the 100-FR-3 Work Plan (DOE/RL-91-53). Well locations are shown on the attached map.

Table 1. 100-FR-3 Well Data

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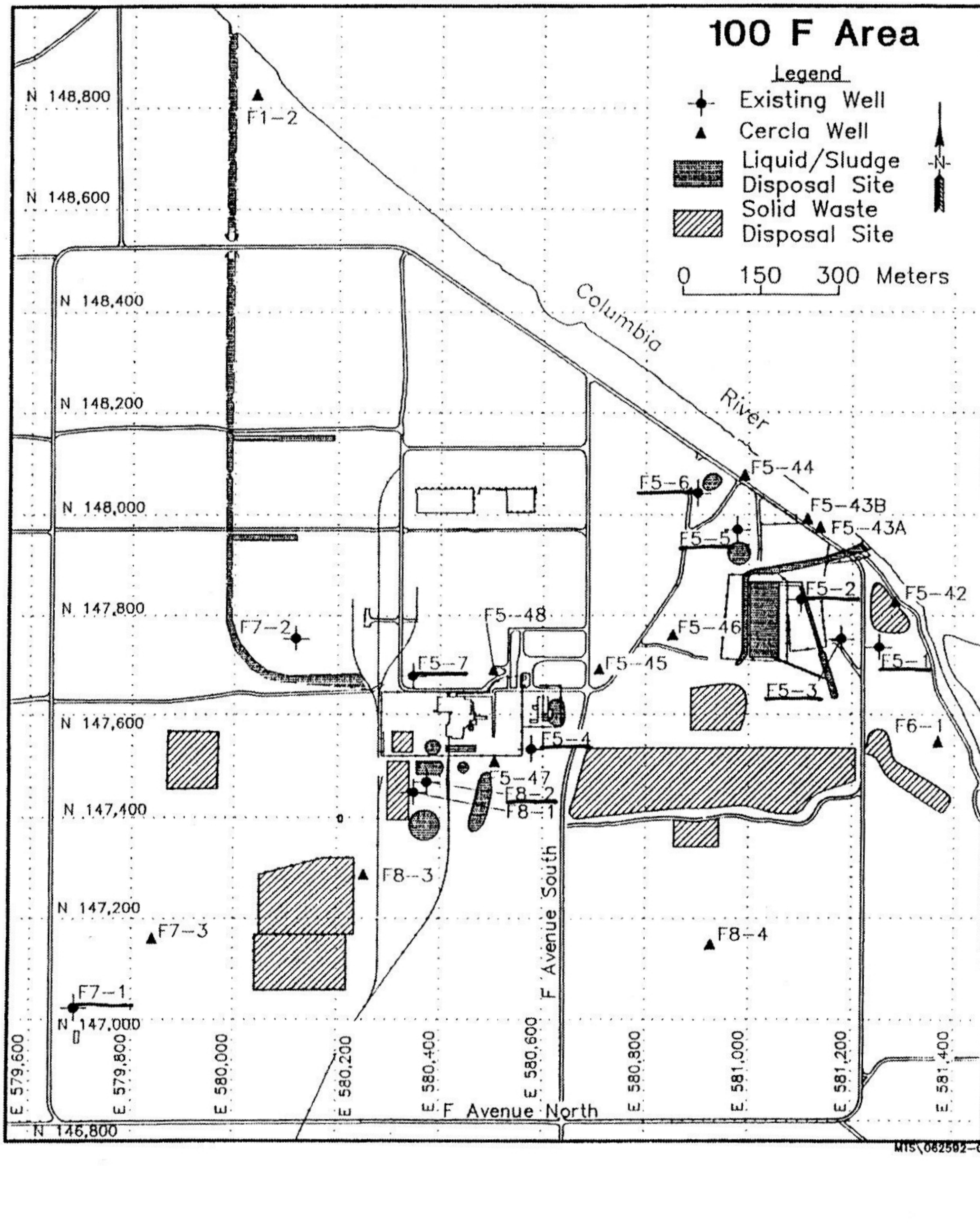
199-F5-43A	CERCLA	Monitors the 116-F-14 retention basin.
199-F7-2	Existing	Monitors the Lewis Canal.
199-F5-44	CERCLA	Monitors the 116-F-13 site.
199-F5-45	CERCLA	Downgradient of the central reactor area.
199-F5-46	CERCLA	Monitors area between the F reactor and the 116-F-14 retention basin.
199-F5-47	CERCLA	Monitors the 116-F-3, 116-F-10, and 116-F-6 sites.
199-F5-48	CERCLA	Monitors the central reactor area.
199-F6-1	CERCLA	Monitors the 116-F-2 trench.
199-F7-3	CERCLA	Monitors area between the Biology Sheep Lot and the 118-F-1 solid waste burial ground.
199-F8-3	CERCLA	Monitors the 118-F-1 solid waste burial ground.
199-F8-4	CERCLA	Monitors contaminant migration south of the reactor site.
199-F5-7	Existing	Monitors the Lewis canal and the central reactor area.
199-F8-2	Existing	Monitors reactor area solid and liquid disposal sites.
199-F5-3	Existing	Monitors downgradient of the 116-F-2 trench
199-F5-6	Existing	Monitors area upgradient of well 199-F5-44
199-F5-5	Existing	Monitors area upgradient of well 199-F5-43A
199-F5-4	Existing	Monitors central reactor area
199-F7-1	Existing	Monitors the Biology Sheep Lot
199-F5-1	Existing	Monitors the 116-F-2 trench
199-F5-2	Existing	Monitors the 116-F-2 trench

*



100 F Area
Legend
Existing Well
Cercla Well
Liquid/Sludge Disposal Site
Solid Waste Disposal Site
0 150 300 Meters
-N-
Columbia River
N 148,800
N 148,600
N 148,400
N 148,200
N 148,000
N 147,800
N 147,600
N 147,400
N 147,200
N 147,000
N 146,800
E 579,600
E 579,800
E 580,000
E 580,200
E 580,400
E 580,600
E 580,800
E 581,000
E 581,200
E 581,400
F1-2
F5-44
F5-6
F5-43B
F5-43A
F5-5
F5-2
F5-42
F5-48
F5-46
F7-2
F5-7
F5-45
F5-3
F5-1
F6-1
F5-4
F5-47
F8-2
F8-1
F8-3
F7-3
F8-4
F7-1
F Avenue South
F Avenue North
MIS\062592-C

Change Number	Federal Facility Agreement and Consent Order	Date
M-15-96-06	**Change Control Form** Do not use blue ink. Type or print using black ink.	7/31/96

Originator
A. C. Tortoso

Phone
373-9631

Class of Change

[ ] I - Signatories [ ] II - Executive Manager [X] III - Project Manager

Change Title

Modifications to the Groundwater Sampling and Analysis Schedules for the 100-FR-3 Operable Unit Groundwater Sampling Project

Description/Justification of Change

Four modifications to the previous groundwater sampling and analysis schedule for the 100-FR-3 Operable Unit (100 NPL Agreement/Change Control #39, December 1992) are being made:

1. Sampling frequency for most wells is reduced from semiannual to annual. Annual sampling will be conducted to coincide with seasonal low river conditions that typically occur during the period September through November.

2. Sampling locations are selected on the basis of proximity to the Columbia River, historical trends in each well, and contaminant plume locations.

3. More frequent sampling of wells with contaminant levels that exceed ARARs or that show increasing trends is conducted using cost-effective methods (e.g., field instruments, Mobile Lab, and no purging of the well).

4. Data validation, as performed during the limited field investigation, is not performed for all new data. Modified data verification and validation steps are adopted that improve cost-effectiveness without compromising data quality. Data evaluation activities are expanded to enhance the quality of information derived from sampling and analysis activities.

The attached Tables 1 and 2 summarize the changes to the sampling program. Minor modifications to the list of specific wells used and constituents analyzed may occur to meet changing field conditions, IRM operational requirements, and the results of data evaluation.

Impact of Change

The changes in sampling result in a more integrated and cost-effective program. The impact of this change includes increased efficiency in obtaining data that can be applied to data quality objectives for multiple programs (e.g., CERCLA remediation activities and DOE Order 5400 surveillance). Sample collection efforts are integrated to the fullest extent possible under a consolidated schedule. Where reductions in number of samples, analytes, and frequency of sampling occur, a minimal or negligible loss of relevant information is expected.

Affected Documents

1) Remedial Investigation/Feasibility Study Work Plan for the 100-FR-3 Operable Unit, Hanford Site, Richland, WA; DOE/RL-91-53, September 1992. Appendix A includes a Quality Assurance Project Plan (QAPjP) as required by EPA guidance. 2) 100 NPL Agreement/ Change Control Form #39, "100-FR-3 Operable Unit Groundwater Monitoring Network," EPA approval December 1992.

Approvals

Arlene C. Tortoso DOE	8/15/96 Date	✓ Approved	__ Disapproved
[illegible] EPA	08/15/96 Date	✓ Approved	__ Disapproved
N/A Ecology	______ Date	__ Approved	__ Disapproved

Table 1. Sampling and Analysis Schedule for the 100-FR-3 Groundwater Project (Page 1 of 2)

Well Number	Facility Monitored/Purpose	RI/FS Round 8 (FY 96)	Proposed Round 9 (FY 97/98)	Sitewide Surveillance[1] (1996)
199-F1-2	"Lewis" canal/near river	SA-1	A-2	
199-F5-1	Retention basin/near river	SA-1	A-2 Q (Sr-90)	A*
199-F5-2 (analog: F5-3)	Retention basin/near river			
199-F5-3	Retention basin/near river		A-2 Q (Sr-90)	A
199-F5-4	Reactor building effluent disposal	SA-1	BA-2(97)	
199-F5-5 (analog: F5-6)	Animal farm liquid effluent			
199-F5-6	Laboratory effluent	SA-1	A-2	A*
199-F5-7 (analog: F5-48)	Reactor building effluent			
199-F5-42	Retention basin/near river	SA-1	A-2	
199-F5-43A	Retention basin/near river	SA-1	A-2	
199-F5-43B (deep well)	Retention basin/near river	SA-1	A-2	
199-F5-44	Laboratory effluent/near river	SA-1	A-2	
199-F5-45	Reactor building effluent	SA-1	BA-2(97) Q (NO3)	
199-F5-46	Reactor building effluent	SA-1	A-2 Q (Cr+6)	A*
199-F5-47	Reactor building effluent	SA-1	BA-2(98)	A*
199-F5-48	Reactor building effluent	SA-1	BA-2(98)	
199-F6-1	Liquid waste disposal trench/near river	SA-1	A-2	
199-F7-1	Background/TCE plume	SA-1	BA-2(98)	A*
199-F7-2	"Lewis" canal	SA-1	BA-2(98)	

Notes: BA = biennial, A = annual, SA = semiannual, and Q = quarterly. The suffix "__-#" attached to the sampling frequency is a code for the constituent list (see Table 2). Numbers in parentheses refer to the first year of biennial sampling. An "*" indicates co-sampling between programs.

[1]PNNL's sitewide surveillance schedule (Bisping, 1996) is included for informational purposes.

Table 1. Sampling and Analysis Schedule for the 100-FR-3 Groundwater Project (Page 2 of 2)

Well Number	Facility Monitored/Purpose	RI/FS Round 8 (FY 96)	Proposed Round 9 (FY 97/98)	Sitewide Surveillance (1996)
199-F7-3	Background/TCE plume	SA-1	BA*-2(97)	A*
199-F8-1	Reactor building effluent	SA-1	BA*-2(97)	A*
199-F8-2	Reactor building effluent	SA-1	BA*-2(98)	A*
199-F8-3	Background/solid waste disposal	SA-1	BA*-2(97)	A*
199-F8-4	Area/downgradient of facilities	SA-1	A-2	
699-71-30	Background/downgradient	SA-1	BA-2(97)	
699-74-44	Background/TCE plume			
699-77-36	Background/TCE plume	SA-1	BA-2(98)	A*
699-80-43s	Background/TCE plume			
699-81-38	Background/TCE plume	SA-1	BA-2(97)	
699-82-32	Background			
699-82-34	Background			
699-83-36	Background			
699-83-47	Background	SA-1	BA-2(98)	A*
699-84-35A	Background		BA-2(97)	A
699-84-35A (piezometers)	Background			
Seep 187-1	Area/shoreline exposure		A-2	
Seep 190-4	Area/shoreline exposure		A-2	
Seep 207-1 (alternate: 211-1)	Area/shoreline exposure		A-2	

Notes: BA = biennial, A = annual, SA = semiannual, and Q = quarterly. The suffix "__-#" attached to the sampling frequency is a code for the constituent list (see Table 2). Numbers in parentheses refer to the first year of biennial sampling. An "*" indicates co-sampling between programs.

[1]PNNL's sitewide surveillance schedule (Bisping, 1996) is included for informational purposes.

100-plan\1fr3-lst.tbl

Table 2. Analysis Suite Codes for the 100-FR-3 Groundwater Project

Analysis/ Parameter	Constituent Code #1 (Round 8--FY96)	Constituent Code #2 (Round 9--FY97/98)
Metals by routine ICP (EPA 6010A-Target Analyte List) Note: Filtered and unfiltered samples for all metals analyses.	Aluminum Antimony Barium Beryllium Cadmium Calcium Chromium Cobalt Copper Iron Magnesium Manganese Nickel Potassium Silver Sodium Vanadium Zinc	Aluminum Antimony Barium Beryllium Cadmium Calcium Chromium Cobalt Copper Iron Magnesium Manganese Nickel Potassium Silver Sodium Vanadium Zinc
Metals by non-routine ICP (EPA 6010A)	Arsenic Lead Selenium Thallium	
Metals: Other (EPA 7470)	Mercury	
Anions by IC (EPA 300.0)	Chloride Fluoride Nitrite Nitrate Phosphate Sulfate	Chloride Fluoride Nitrate Sulfate
Volatile Organics	TCL (inc. TCE)	TCL (inc. TCE)*
Radionuclide screening:	Gross alpha Gross beta Activity scan	Gross alpha Gross beta Activity scan*
Specific radionuclides:	Carbon-14 Strontium-90 Tritium	Strontium-89/90* Tritium
Miscellaneous parameters:	Specific conductance pH	
Field parameters:	pH Specific conductance Temperature	pH Specific conductance Temperature Turbidity

Notes: Constituent code #1 list is from the Sample Authorization Form for the sampling event. It is based on the constituent list presented in 100 NPL Change Control Form #39, Dec. 1992. Code #2 is based on TPA Change Control Form M-15-96-06, August 1996.

* = selected wells only; ICP = inductively coupled plasma; IC = ion chromatography.

100-plan\2fr3-con.tbl (rev. 1/2/97)

Change Number	Federal Facility Agreement and Consent Order Change Control Form	Date
M-15-99-02	Do not use blue ink. Type or print using black ink.	7/14/99

Originator
M. J. Furman

Phone
373-9630

Class of Change

[ ] I - Signatories [ ] II - Executive Manager [X] III - Project Manager

Change Title
Modifications to the Groundwater Sampling and Analysis for the 100-FR-3 Operable Unit Groundwater Sampling Project

Description/Justification of Change

The following encapsulates changes to the 100-FR-3 Operable Unit Monitoring as of 07/31/96:

1) Wells 199-F5-2, 199-F5-7 and 199-F8-1 were deleted as part of the site-wide decommissioning program. The 100-FR-3 Operable Unit continues to have adequate coverage from remaining groundwater monitoring wells. Changes in groundwater conditions or elevation of constituent levels could require new well installations. Well placements are selected on the basis of proximity to the Columbia River, historical trends in each well, and contaminant plume locations.

2) Integration of groundwater programs within the Hanford Site has eliminated overlap in sampling schedules and constituents. Surveillance and 100-FR-3 Operable Unit monitoring were added to the Integrated Monitoring Plan for the Hanford Groundwater Monitoring Project (PNNL-11989) in September 1998. Future changes to surveillance monitoring and the 100-FR-3 Change Control Form will be reflected in revisions to the Integrated Monitoring Plan.

3) Data validation will follow requirements outlined in the Integrated Monitoring Plan (PNNL-11989).

4) Analytical change

The attached Tables 1 and 2 summarize the changes to 100-FR-3 sampling. Minor modifications to the list of specific wells used and constituents analyzed may occur to meet the changing field conditions and the results of data evaluation.

Impact of Change

The changes continue the trend established in Change Control Form M-15-96-06 to produce a more integrated and cost-effective system. Changes to the monitoring network as a result of excavation in support of remediation are also included. Sample collection efforts will be integrated further under the Integrated Monitoring Plan (PNNL-11989). Where reductions in number of samples, analytes, and frequency of sampling occur, a minimal or negligible loss of relevant information is expected.

Affected Documents
1) Remedial Investigation/Feasibility Study Work Plan for the 100-FR-3 Operable Unit, Hanford Site, Richland, WA; DOE/RL-91-53, September 1992. 2) 100 NPL Agreement/Change Control Form #39, "100-FR-3 Operable Unit Groundwater Monitoring Network," EPA approval December 1992; 3) Federal Facility Agreement and Consent Order Change Control Form, Change Number M-15-96-06.

Approvals

M. J. Furman
DOE — Date 6/22/99 — ✓ Approved ___ Disapproved

EPA — Date 7-14-99 — ✓ Approved ___ Disapproved

N/A
Ecology — Date ___ — ___ Approved ___ Disapproved

Table 1. Sampling and Analysis Schedule for 100-FR-3 Groundwater Project (Page 1 of 2)

Well Number	Facility Monitored/Purpose	Schedule	Program	Change
199-F1-2	Lewis canal/near river	A	FRLFI	None
199-F5-1	116-F-2 Retention basin/near river	A/Q(Sr-90)	FRLFI	None
199-F5-2	107-F Retention basin/near river	N/A	N/A	Decommissioned
199-F5-3	116-F-2 Retention basin/near river	A/Q(Sr-90)	FRLFI/S	None
199-F5-4	105-F Reactor building effluent disposal	2-O	FRLFI	None
199-F5-5	116-F-9 Animal farm liquid effluent	N/A	N/A	Reserve
199-F5-6	Biological and pharmacological laboratory effluent	A	FRLFI/S	None
199-F5-7	116-F-2 Retention basin/ reactor building effluent	N/A	FRLFI	Decommissioned
199-F5-42	107-F Retention basin/near river	A	FRLFI	None
199-F5-43A	107-F Retention basin/near river	A	FRLFI	None
199-F5-43B (deep well)	107-F Retention basin/near river	A	FRLFI	None
199-F5-44	Biological and pharmacological laboratory effluent/near river	A	FRLFI	None
199-F5-45	105-F Reactor building effluent	2-O/ Q(NO_3)	FRLFI	None
199-F5-46	105-F Reactor building effluent	A/Q(Cr^{+6})	FRLFI/S	None
199-F5-47	105-F Reactor building effluent	2-E	FRLFI/S	None
199-F5-48	105-F Reactor building effluent	2-E	FRLFI	None
199-F6-1	116-F-2 Liquid waste disposal trench/near river	A	FRLFI	None
199-F7-1	Background/TCE plume	2-E	FRLFI/S	None
199-F7-2	116-F-1 "Lewis" canal	2-E	FRLFI	None
199-F7-3	Background/TCE plume	2-O	FRLFI/S	None

Notes: 2-E = biennial sampling, even years (starting 1998), A = annual sampling, 2-O = biennial sampling, odd years (starting 1997), S = Surveillance Monitoring, FRLFI = 100-FR-3 Limited Field Investigation N/A = not applicable/decommissioned well

Table 1. Sampling and Analysis Schedule for 100-FR-3 Groundwater Project (Page 2 of 2)

Well Number	Facility Monitored/Purpose	Schedule	Program	Change
199-F8-1	105-F Reactor building effluent	N/A	N/A	Decommissioned
199-F8-2	105-F Reactor building effluent	2-E	FRLFI/S	None
199-F8-3	Background/118-F-1 solid waste burial ground #2	2-O	FRLFI/S	None
199-F8-4	Area downgradient of facilities	A	FRLFI	None
699-71-30	Background/downgradient	2-O	FRLFI	None
699-74-44	Background/TCE plume	N/A	N/A	Reserve
699-77-36	Background/TCE plume	2-E	FRLFI	None
699-80-43s	Background/TCE plume	N/A	N/A	Reserve
699-81-38	Background/TCE plume	2-O	FRLFI	None
699-82-32	Background	N/A	N/A	Reserve
699-82-34	Background	N/A	N/A	Reserve
699-83-36	Background	N/A	N/A	Reserve
699-83-47	Background	2-E	FRLFI/S	None
699-84-35A	Background*	2-O	FRLFI/S	None
Seep 187-1	Area/shoreline exposure	A	FRLFI	None
Seep 190-4	Area/shoreline exposure	A	FRLFI	None
Seep 207-1	Area/shoreline exposure	A	FRLFI	None

Notes: 2-E = biennial sampling, even years (starting 1998), A = annual sampling, 2-O = biennial sampling, odd years (starting 1997), S = Surveillance Monitoring, FRLFI = 100-FR-3 Limited Field Investigation, N/A = not applicable/decommissioned well, * = Piezometer not sampled/reserved for future use

Table 2. Analysis Suite Codes for the 100-FR-3 Groundwater Project

Analysis/Parameter	Constituent	
Metals by routine ICP (EPA 6010A-Target Analyte List) Note: Filtered samples only for all metal analysis	Aluminum Antimony Barium Beryllium Cadmium Calcium Chromium Cobalt Copper	Iron Magnesium Manganese Nickel Potassium Silver Sodium Vanadium Zinc
Anions by IC (EPA 300.0)	Chloride Fluoride	Nitrate Sulfate
Volatile Organics	TCL (including TCE)**	
Radionuclide screening	Gross alpha Gross beta Activity scan*	
Specific radionuclides	Strontium-90 Tritium	
Field parameters	PH Specific conductance Temperature Turbidity	

Note: * = Selected wells only, ICP= Inductively coupled plasma IC = Ion chromatography, ** - TCL samples obtained from wells identified as monitoring "TCE plume" in Facility Monitored/Purpose column of Table 1.
Constituent selection based on TPA Change Control Form M-15-96-06, August 1996.

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Change Number	Federal Facility Agreement and Consent Order Change Control Form	Date
M-15-01-06	Do not use blue ink. Type or print using black ink.	12/13/01

Originator
M. J. Furman

Phone
373-9630

Class of Change

[ ] I - Signatories [ ] II - Executive Manager [X] III - Project Manager

Change Title
Modifications to the Groundwater Sampling and Analysis for the 100-FR-3 Operable Unit Groundwater Sampling Project

Description/Justification of Change

Change quarterly Sr-90 sampling for well 199-F5-1 to annual sampling. Remove 199-F5-3 from well list due to inability to obtain samples (well dry).

The attached Tables 1 and 2 summarize the changes to 100-FR-3 sampling. Minor modifications to the list of specific wells used and constituents analyzed may occur to meet the changing field conditions and the results of data evaluation.

Impact of Change

Information gathered from annual sampling will continue to adequately reflect groundwater conditions.

Affected Documents
1) Remedial Investigation/Feasibility Study Work Plan for the 100-FR-3 Operable Unit, Hanford Site, Richland, WA; DOE/RL-91-53, September 1992. 2) 100 NPL Agreement/Change Control Form #39, "100-FR-3 Operable Unit Groundwater Monitoring Network," EPA approval December 1992; 3) Federal Facility Agreement and Consent Order Change Control Form, Change Number M-15-96-06, 4) Federal Facility Agreement and Consent Order Change Control Form, Change Number M-15-99-02.

Approvals

DOE	12/13/01 Date	Approved	Disapproved
EPA	12-17-01 Date	Approved	Disapproved
Ecology	Date	Approved	Disapproved

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Table 1. Sampling and Analysis Schedule for 100-FR-3 Groundwater Project

Well Number	Facility Monitored/Purpose	Schedule	Program	Change
199-F1-2	Lewis canal/near river	A	FRRI	None
199-F5-1	116-F-2 Liquid waste disposal trench/near river	A	FRRI	Quarterly to Annual Sr-90 Sampling
199-F5-3	116-F-2 Liquid waste disposal trench/near river	A	FRRI/S	Removed from schedule - dry
199-F5-4	105-F Reactor building effluent disposal	2-O	FRRI	None
199-F5-5	116-F-9 Animal farm liquid effluent	N/A	N/A	Reserve
199-F5-6	Biological and pharmacological laboratory effluent	A	FRRI/S	None
199-F5-42	107-F Retention basin/near river	A	FRRI	None
199-F5-43A	107-F Retention basin/near river	A	FRRI	None
199-F5-43B (deep well)	107-F Retention basin/near river	A	FRRI	None
199-F5-44	Biological and pharmacological laboratory effluent/near river	A	FRRI	None
199-F5-45	105-F Reactor building effluent	2-O/ Q(NO_3)	FRRI	None
199-F5-46	105-F Reactor building effluent	A/Q(Cr^{+6})	FRRI/S	None
199-F5-47	105-F Reactor building effluent	2-E	FRRI/S	None
199-F5-48	105-F Reactor building effluent	2-E	FRRI	None
199-F6-1	116-F-2 Liquid waste disposal trench/near river	A	FRRI	None
199-F7-1	Background/TCE plume	2-E	FRRI/S	None
199-F7-2	116-F-1 "Lewis" canal	2-E	FRRI	None
199-F7-3	Background/TCE plume	2-O	FRRI/S	None
199-F8-2	105-F Reactor building effluent	2-E	FRRI/S	None
199-F8-3	Background/118-F-1 solid waste burial ground #2	2-O	FRRI/S	None
199-F8-4	Area downgradient of facilities	A	FRRI	None
699-71-30	Background/downgradient	2-O	FRRI	None
699-74-44	Background/TCE plume	N/A	N/A	Reserve
699-77-36	Background/TCE plume	2-E	FRRI	None
699-80-43S	Background/TCE plume	N/A	N/A	Reserve
699-81-38	Background/TCE plume	2-O	FRRI	None
699-82-32	Background	N/A	N/A	Reserve
699-82-34	Background	N/A	N/A	Reserve
699-83-36	Background	N/A	N/A	Reserve
699-83-47	Background	2-E	FRRI/S	None
699-84-35A	Background(See Table 2)	2-O	FRRI/S	None
Seep 187-1	Area/shoreline exposure	A	FRRI	None
Seep 190-4	Area/shoreline exposure	A	FRRI	None
Seep 207-1	Area/shoreline exposure	A	FRRI	None

Notes: 2-E = biennial sampling, even years (starting 1998), A = annual sampling, 2-O = biennial sampling, odd years (starting 1997), S = Surveillance Monitoring, FRRI = 100-FR-3 Remedial Investigation N/A = not applicable/decommissioned well